Nuclear MythBusters – Hunting Anti-Nuclear Ghosts

Jeffrey A. Mahn
Nuclear Engineer (Retired)
Albuquerque, NM USA
jamahn47@gmail.com

WHO YA
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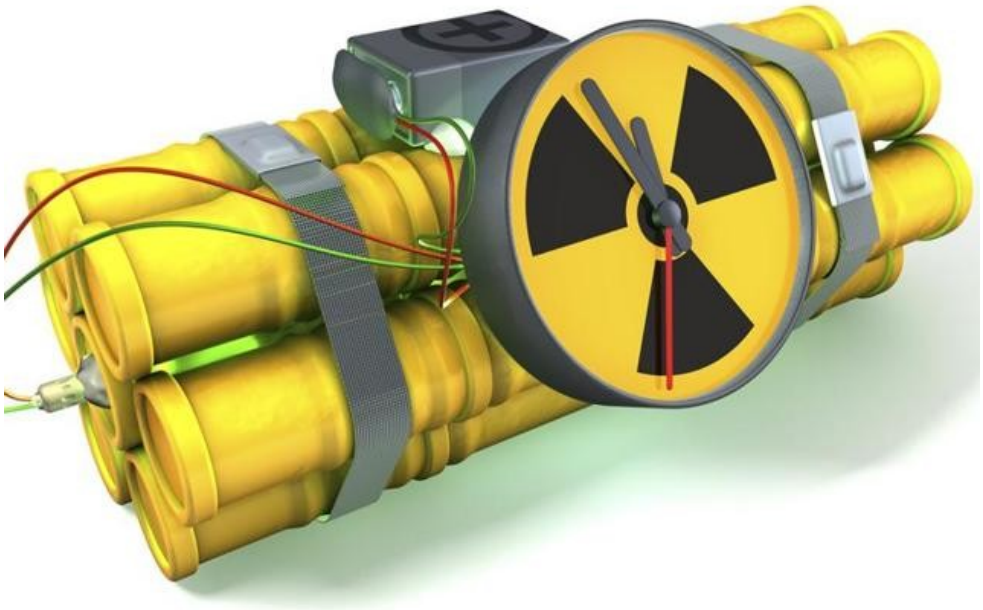
Dirty Bomb Myth

Fictional Dirty Bomb



The Dirty Bomb

- What it is – type of radiological dispersal device (RDD) that combines conventional explosive with radioactive material
- Its purpose – to create mass panic as weapon of terror by contaminating land area with radioactive material
- Consequences – main danger from explosion which can cause serious injuries and property damage; radiation released likely insufficient to cause biological harm

Dirty Bomb Material

- Potential radioactive materials would have to be illegally obtained from secured radioactive sources routinely used at hospitals, research facilities, or industrial and construction sites
- Vast majority of such materials would not be harmful; only handful of potentially obtainable radioisotopes deemed suitable for causing significant radiation exposure to people
- Attributes necessary for effective radiological weapon unlikely to be

Dirty Bomb Material (cont.)

- Source material for effective radiological weapon must
  - not be so radioactive as to cause immediate harm to bomb makers
  - be sufficiently radioactive to create radiological threat to public health or societal disruption at site of explosion
  - be sufficiently dispersible to effectively contaminate area around explosion
  - not require so much radiation shielding material as to prohibit transport and handling of bomb

Dirty Bomb Effects

- Extent of local contamination dependent on
  - size of explosive
  - amount and type of radioactive material
  - weather conditions
- Likely material dispersal only within few hundred meters of explosion
- Radioactive material becomes less concentrated and less harmful as dispersed; cleanup is primary consequence of concern

Dirty Bomb Attacks

No successful dirty-bomb attacks anywhere in world, despite two reported attempts

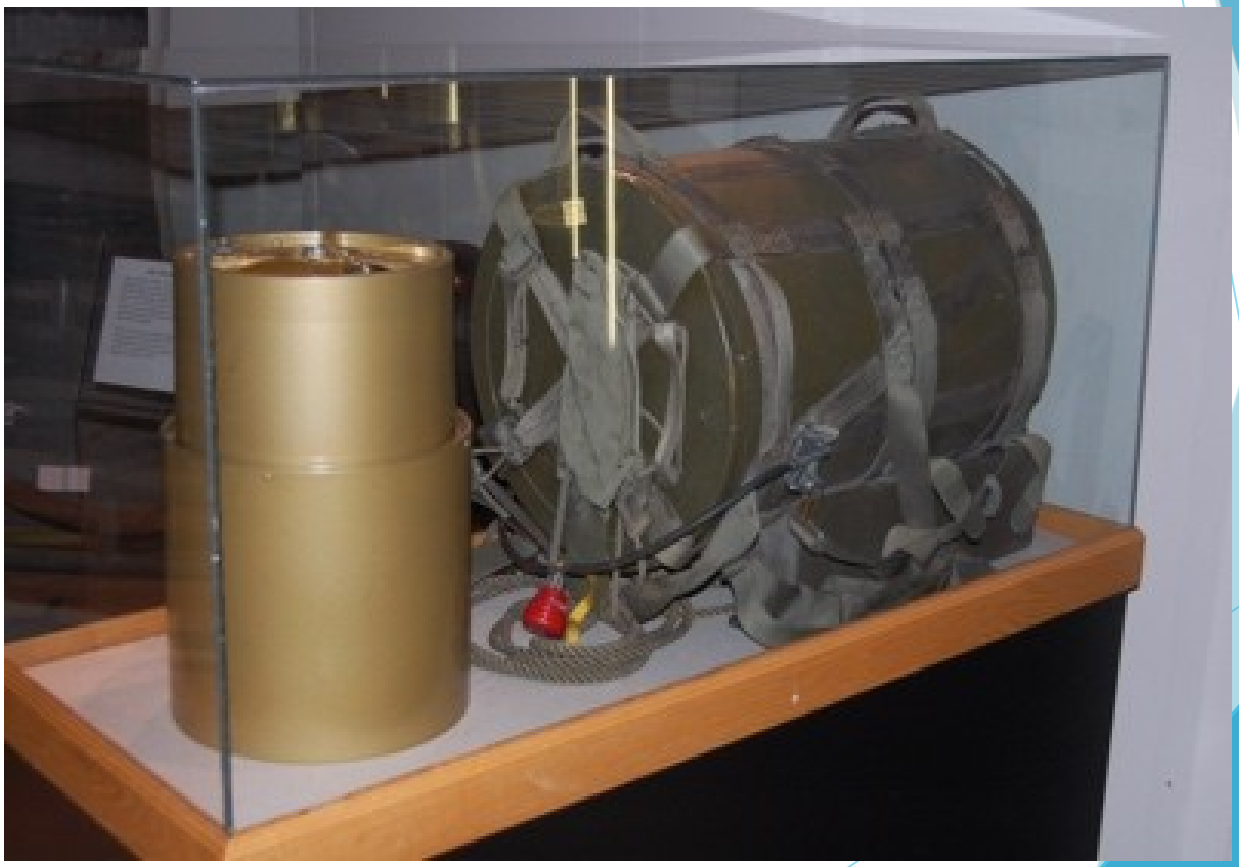
- Chechnya rebels reportedly planted bomb containing dynamite and cesium-137 in Moscow's Izmaylovo Park in 1995; Russian security services reportedly discovered location and defused bomb
- Chechnya's intelligence service reportedly found and defused dirty bomb placed near Chechnyan railway line in 1998

Suitcase Nuke Myth

Fictional Suitcase Nuke

Portable Nuclear Weapons

Both U.S. and Soviet Union developed nuclear weapons small enough to be portable in specially-designed back-packs during 1950s and 1960s



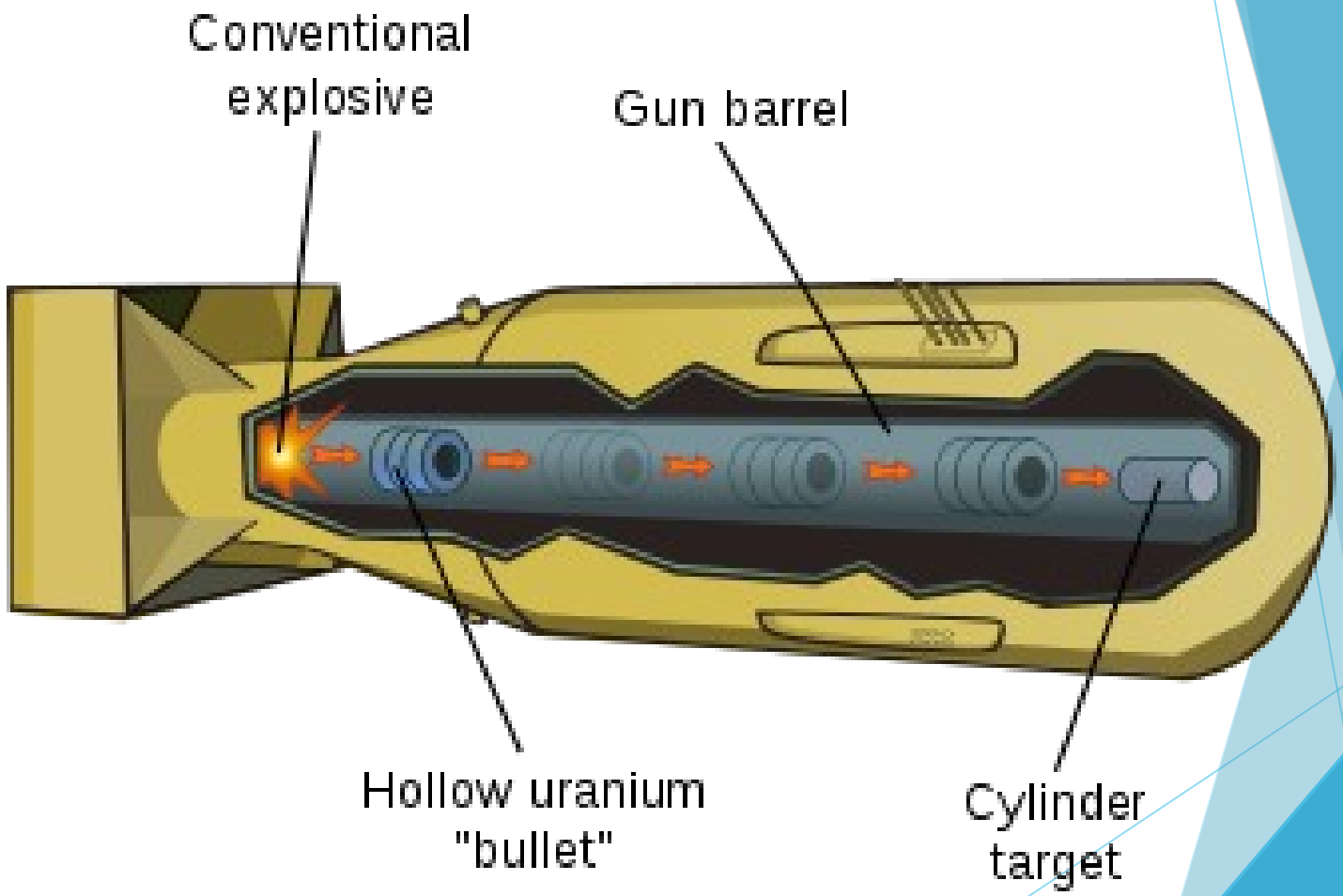
Suitcase Nuke

- Suitcase-sized nuclear devices first became nuclear terrorism concern in mid-1970s and attracted public attention in 1997 thanks to “60 Minutes” interview with former Russian National Security Chief
- Concept of “suitcase nuke” as potential weapon of terror evolved from claims of missing suitcase-size nuclear bombs following collapse of Soviet Union
- Changing claims of former Russian officials over time along with Russian government denials have reduced credibility of threat
- Claim that such devices secretly deployed in U.S. by Russia years ago led to searches that found no evidence to support claim

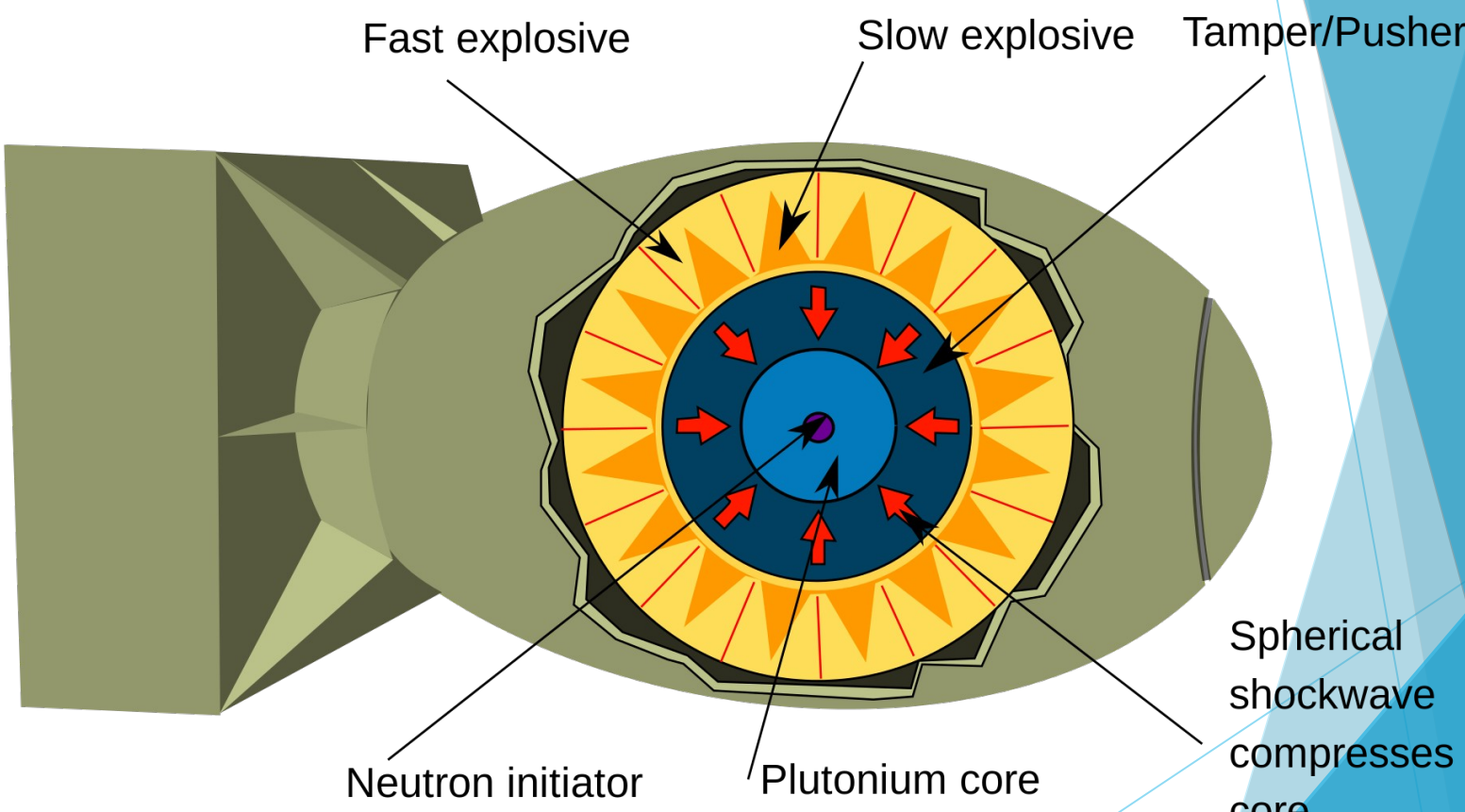
Suitcase Nuke (cont.)

- Experts and intelligence officials say threat of suitcase nuke gets vastly more attention than it deserves
  - Highly unlikely that terrorist cell could obtain critical mass of either uranium-235 or plutonium-239, or essential weapon components like neutron generator
  - Gun-type weapon too large for “suitcase” transport
  - Implosion-type weapon requires very large quantity of explosives, making it too bulky for “suitcase”
  - Kiloton yield for suitcase-sized device requires fusion boosting or very dense tamper material to increase fissile material utilization

Gun-Type Assembly Device



Implosion-Type Device

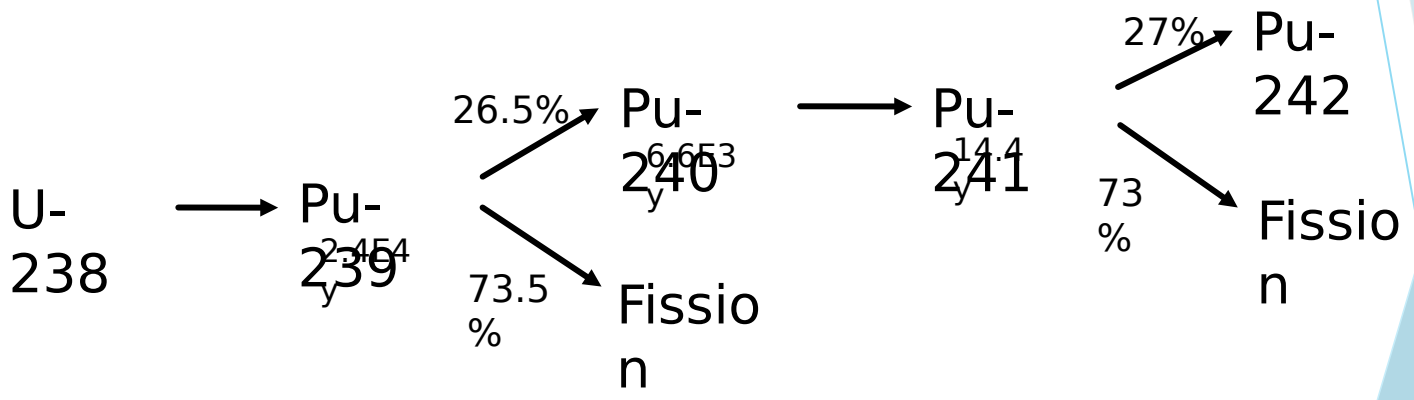


Suitcase Nuke (cont.)

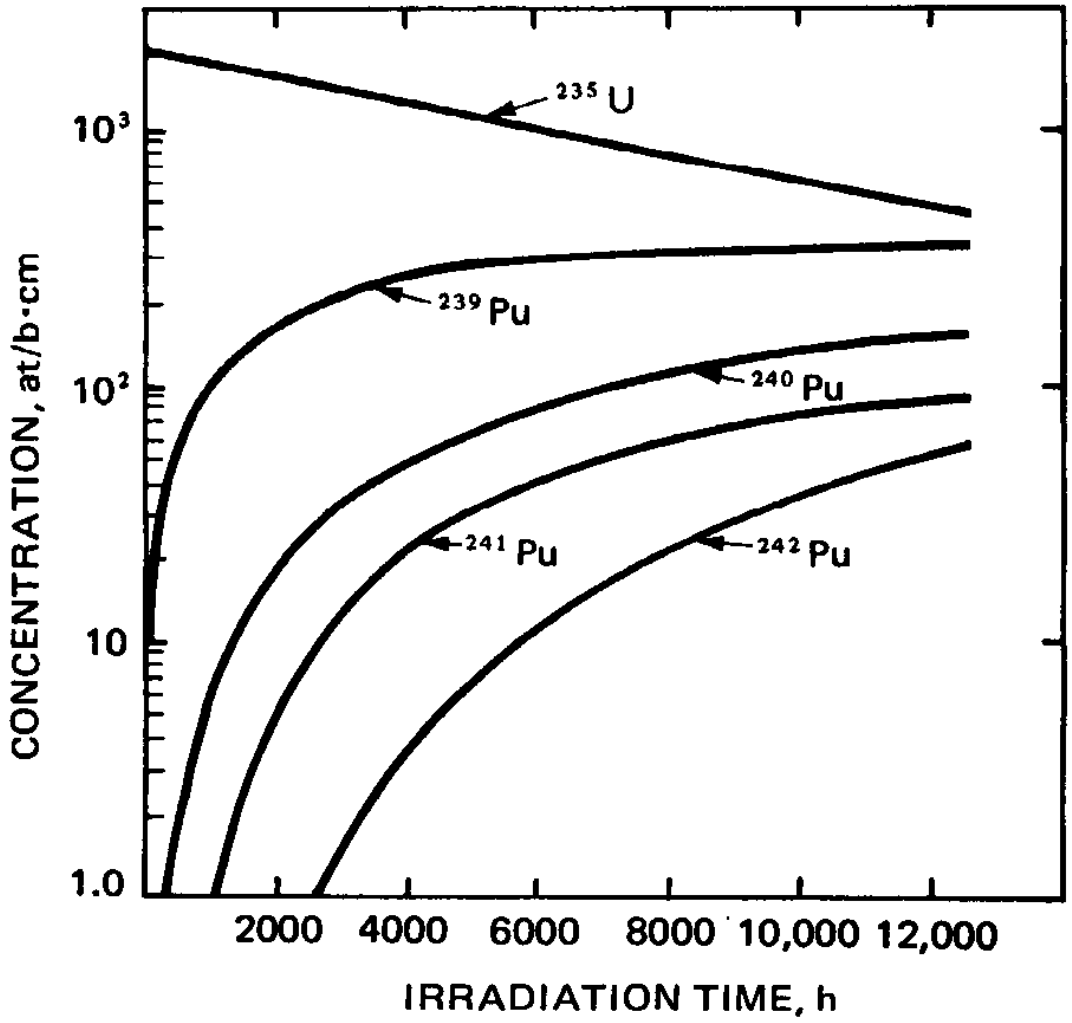
- While suitcase nukes abound in popular fiction, true suitcase nuke would be highly complex to produce, require significant upkeep, and cost a small fortune
- Such devices unlikely to have remained serviceable even *if* they existed outside of governmental control
- Nevertheless, existence of such weapons — and their potential usefulness, yield and lethality after prolonged period of years — remains

Reprocessing Used Nuclear Fuel Will Lead to Proliferation of Nuclear Weapons Myth

Production of Plutonium in LWR Fuel



Pu Buildup in Light Water Reactor Fuel



Why Pu from Nuclear Fuel Reprocessing Not Suitable for Nuclear Weapons

- Normal light-water reactor fuel cycle generates too much Pu-240 (>18% of used nuclear fuel plutonium content) for use in nuclear weapon (requires >93% Pu-239, or <7% Pu-240)
- Converting reactor-grade plutonium into weapon-grade plutonium impractical and dangerous
  - One neutron difference in isotopic masses makes separation virtually impossible; technology does not exist
  - Pu-240 has significant spontaneous fission rate, making it relatively strong neutron emitter (neutron radiation more biologically harmful than gamma-ray radiation)
  - Pu-241 decays to Am-241, a strong alpha emitter presenting self-heating problems and radiotoxicity problems if inhaled or ingested

World Nuclear Fuel Reprocessing Capacity (tonnes U per year)

LWR Fuel	France, La Hague (1976)	1700
	UK, Sellafield (THORP - 1994)	900
	Russia, Ozersk (Mayak - 1978)	400
	Total LWR (approx.)	3000
Other Nuclear Fuels	UK, Sellafield (Magnox - 1964)	1500
	India (PHWR, 4 plants - 1982)	260
	Total other (approx.)	1760
	Total Commercial Capacity	4760

Source: Nuclear Energy Data 2019, OECD Nuclear Energy Agency

Experience with Nuclear Fuel Reprocessing

- Used nuclear fuel reprocessed outside U.S. for decades and nuclear weapon-grade material proliferation has not been a concern
- Potential for nuclear weapon proliferation from used nuclear fuel reprocessing in U.S. is political problem, not real problem

Nuclear Power Plants Can Explode Like Nuclear Bombs Myth

Nuclear Power Plants and Nuclear Bombs Have Different Fuel Compositions

- Nuclear fuel in nuclear power plants low-enriched uranium, mostly non-fissionable U-238 atoms
- Nuclear bombs need highly-enriched uranium, mostly fissionable U-235 atoms, or plutonium-239
- In nuclear bomb, subcritical mass of U-235 or Pu-239 becomes supercritical so fission events increase extremely rapidly (i.e., in uncontrolled manner)
  - Supercritical mass achieved with aid of high explosives

Nuclear Reactors Designed to Avoid Uncontrolled Fission

- Neutron population in nuclear reactor controlled by using neutron absorbing materials to ensure that U-235 atoms fission in controlled manner
- Even in melted condition, nuclear reactor fuel cannot achieve supercritical configuration
  - Demonstrated by Three Mile Island and Fukushima accidents

Nuclear Weapon vs. Nuclear Reactor*

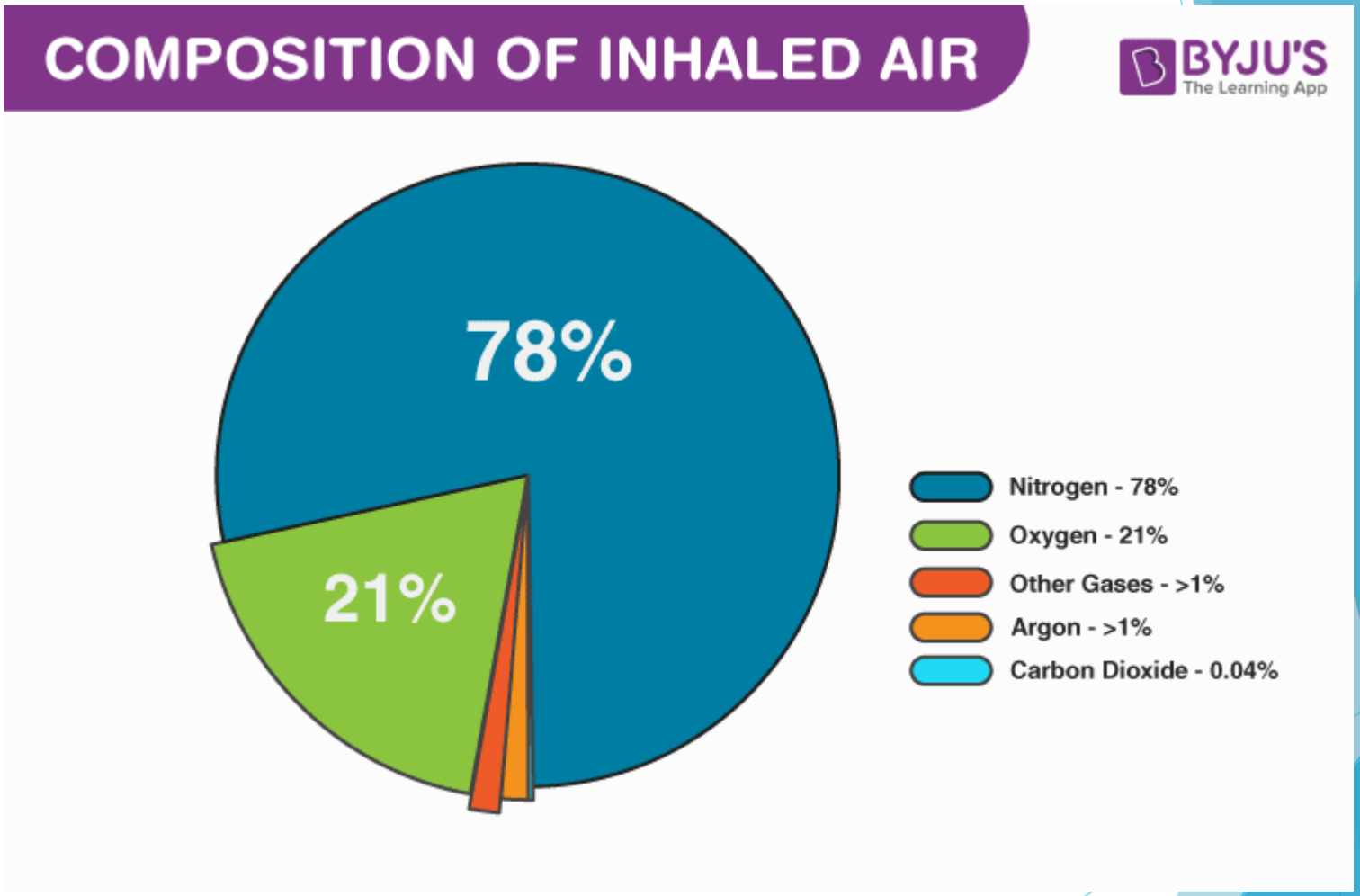
Nuclear Weapon

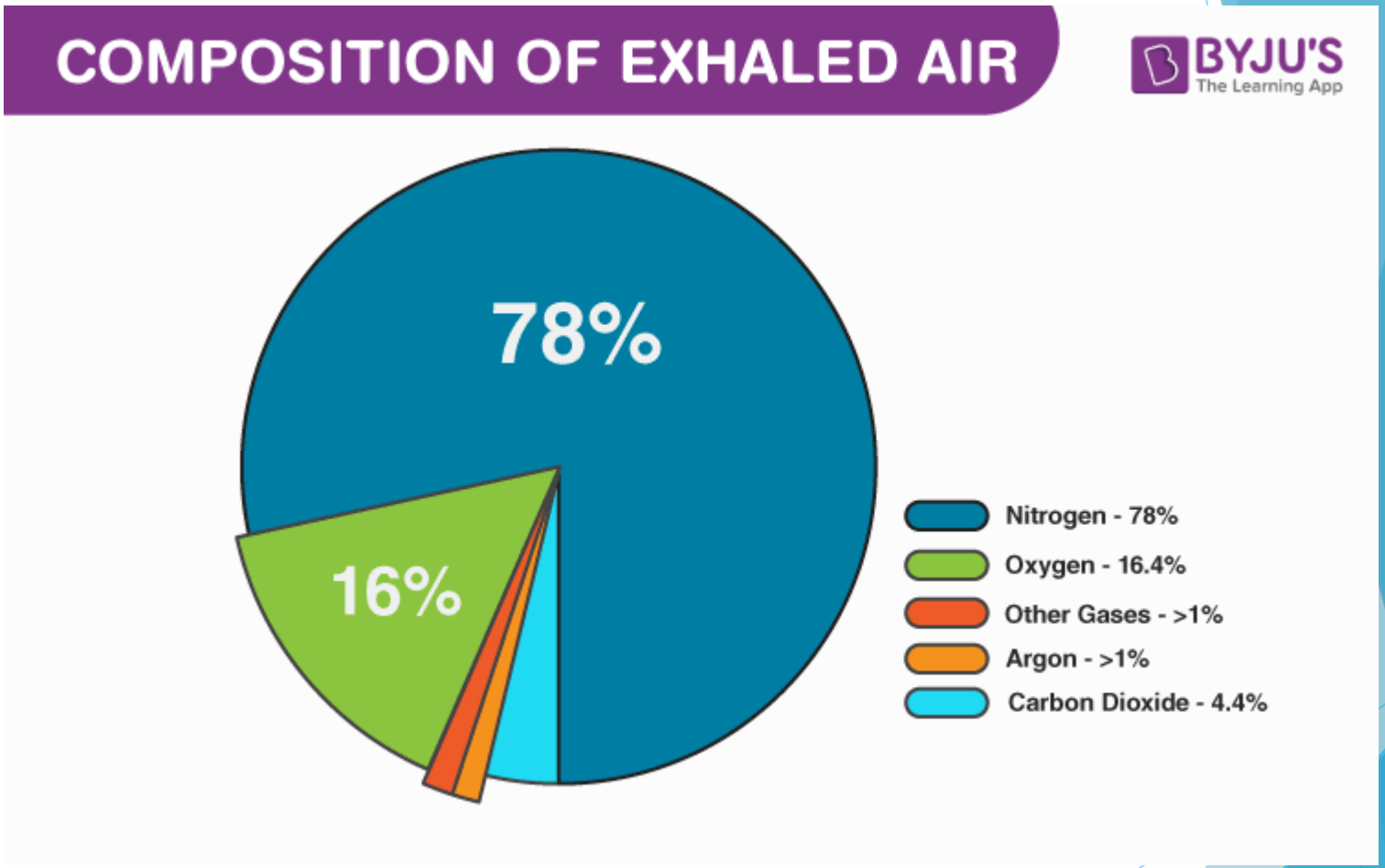
Prompt Critical Reactor

* Neutron population vs time plots are approximate representations for illustration purposes only

Supplemental Slides

COMPOSITION OF INHALED AIR




COMPOSITION OF EXHALED AIR
BYJU'S
The Learning App
78%
16%
Nitrogen - 78%
Oxygen - 16.4%
Other Gases - >1%
Argon - >1%
Carbon Dioxide - 4.4%